THE

JOURNAL OF GEOLOGY

MAY-JUNE, 1893.

ON THE TYPICAL LAURENTIAN AREA OF CANADA.

THE name Laurentian was given by Logan in 1854 to the great series of rocks forming the Laurentides or Laurentian Mountains, a district of mountainous country rising to the north of the River and Gulf of St. Lawrence, and extending in an unbroken stretch along the shore of the latter from Quebec to Labrador, a distance of nine hundred miles. This district, with its continuation to the west as far as Lake Huron, being situated in the Province of Quebec and the adjacent portion of the Province of Ontario, and forming part of the main Protaxis of the continent, is the "Original Laurentian Area" of Logan. The Laurentian rocks are now known to extend far beyond the limits of this area to the west and north, constituting, as they do, by far the greater part of the Protaxis, and underlying (with subordinate patches of Huronian) an area of somewhat over two million square miles.[1] The area above referred to is, however, the one which was first studied and described; it is the "Typical Laurentian area," and to it the observations in the present paper will be as far as possible confined.

A general exploration of the area in question, and a more detailed study of a small part of it—the Grenville District—situated in the counties of Argenteuil and Terrebonne in the Prov-

[1] Accepting the distribution of the Laurentian in the far north, given by Dr. G. M Dawson, as correct, the area is 2,001,250 square miles. This does not include the outlying and separated areas occurring in Newfoundland, New York State and Michigan.

ince of Quebec, was carried out by Logan and his assistants in the early years of the Canadian Geological Survey. An excellent résumé of the results of these studies is given in the "Geology of Canada," published in 1863, which contains not only a good description of the general petrographical character and arrangement of the rocks which make up the area, but is accompanied by an atlas containing two maps illustrating this description, one showing the general distribution of the Laurentian in the eastern part of the Dominion, and the other its stratigraphical relations in the smaller area above referred to.

As a result of these studies, Logan announced his belief that the Laurentian System consisted of two great unconformable series of sedimentary rocks, to which he gave the names Upper and Lower Laurentian. The latter he considered to be divisible into a lower and an upper portion, which sub-divisions he regarded as probably conformable to one another. In the course of time these several series came to be known as the Anorthosite or Norian Series, the Grenville Series and the Fundamental or Ottawa Gneiss. Logan's views may then be represented as follows:

Anorthosite or Norian Series,	Upper Laurentian.	
Grenville Series,	Upper portion	Lower
Fundamental or Ottawa Gneiss,	Lower portion	Laurentian.

Subsequently, in the southeastern corner of the Province of Ontario, in the district lying to the north of the eastern end of Lake Ontario, another series of rocks was discovered—the so-called Hastings Series. Logan supposed this to come in above the Grenville Series, while Vennor, who subsequently examined the district, believed it to be equivalent to the lower part of the Grenville Series already mentioned.

When these investigations were carried out, the microscope had not as yet been seriously employed in petrographical work. The precise composition of many of the rocks making up the several series was not recognized, the effects produced by great dynamic action were not duly considered, and the foliation possessed in a high degree by some and to a certain extent by almost all these

rocks was considered, in all cases, to be a more or less obliterated survival of original bedding. The detailed mapping in the field, accompanied by microscopical work in the laboratory, by which alone conclusive results can be obtained in working out the structure of complicated areas of crystalline schists, was not carried out, in fact in many districts the construction of detailed maps was at that time practically impossible. It is not surprising therefore that, although excellent in the main, some of the results arrived at have since proved to be erroneous.

It is proposed, in the present paper, to place before the readers of this JOURNAL in as brief a manner as possible, a general account of the several series of rocks occurring in this area, and to point out what, in the opinion of the present writer, seems to have been satisfactorily established concerning the statigraphical position and mutual relations of these ancient rocks and what still remains to be determined by further study, and in conclusion to give a short sketch of the evolution of this portion of the continent.

The Fundamental Gneiss. — Exposed over very wide stretches of country in Canada, and making up in all probability by far the larger part of the Archean Protaxis, is the "Fundamental Gneiss," sometimes called, from its great development about the upper waters of the Ottawa River, the "Ottawa Gneiss." It is composed essentially of orthoclase gneiss, usually reddish or greyish in color. Of this there are a number of varieties, differing from one another in size of grain, relative proportion of constituent minerals and in the distinctness of the foliation or banding. It is sometimes rich in quartz, while at other times this mineral is present in but very small amount. It is usually poor in mica and bisilicates. Dark bands of amphibolite are not uncommon, while basic hornblende or pyroxene gneisses occur in some places. Other schistose rocks are rarely found. Over great areas it is often nearly uniform in character and possesses a foliation which can only be recognized when exposures of considerable size are examined. On this account it is often referred to as a granitoid gneiss, a designation, however, which by no

means accurately describes it as a whole. At a locality cited by Sir William Logan, as one where it is typically developed, namely, Trembling Mountain in the above mentioned Grenville Area, it consists of a fine grained reddish orthoclase gneiss, with distinct but not very decided foliation, containing here and there bands of orthoclase gneiss of somewhat different character, as well as bands or layers of a dark amphibolite.

How much of this Fundamental Gneiss really consists of eruptive material is not known. The indistinct foliation, in many cases at any rate, is not a survival of original bedding, but is clearly due to movements in a plastic mass. It is often possible to recognize the existence of an indistinctly foliated gneiss intruded into more distictly foliated gneiss. The gneiss, in some cases, shows excellently well-marked cataclastic structure, while in other cases this is not distinct. The evidence accumulated goes to show that the Fundamental Gneiss consists of a complicated series of rocks of unknown origin, but comprising a considerable amount of material of intrusive character.

The Grenville Series.—In certain parts of the Laurentian area, and notably in the Grenville district before mentioned, the Laurentian has a decidedly different petrographical development. Orthoclase gneiss is still the predominating rock, but it presents a much greater variety in mineralogical composition, and is much more frequently well foliated, often occurring in well defined bands or layers like the strata of later formations.

Amphibolites are abundant, also hornblende schists, heavy beds of quartzite and numerous thick bands of crystalline limestone or marble, all these rocks being interbanded or interstratified with one another. In the vicinity of the limestones the variety in petrographical character is especially noticeable; garnets often occur abundantly in the gneiss, the quartzite and the hornblende schist, as well as in the limestone itself, beds of pure garnet rock being found in places. Pyroxene, wollastonite and other minerals are also abundant, while the presence of graphite disseminated through the limestones and their associated rocks, often in such abundance as to give rise to deposits of economic

value, is of especial significance. This mineral which is not found in the Fundamental Gneiss, occurs usually in little disseminated scales but occasionally in veins. The limestones are thoroughly crystalline, generally somewhat coarse in grain and often nearly pure. They usually, however, contain grains of serpentine, pyroxene, mica, graphite or other minerals, of which over fifty species have been noted. They are often interstratified in thin bands with the gneiss, in places are very impure, and may be traced for great distances along the strike, being apparently as continuous as any other element of the series. This development of the Laurentian is known as the Grenville Series, and has been considered by all observers to be above and to rest upon the Fundamental Gneiss. In it are found all the mineral deposits of economic value—apatite, iron ore, asbestos, etc., which occur in the Laurentian. The rocks of this series, though generally highly inclined, over some large areas lie nearly horizontal or are inclined at very low angles, but even in such cases they show evidence of having been subjected to great pressure, resulting in some cases in the horizontal disruption of certain of the beds.

The areas occupied by the Grenville series although of very considerable extent, being known to aggregate many thousand square miles, are probably small as compared with those underlain by the Fundamental Gneiss. The relative distribution of the two series has not been ascertained except in a general way in the more easily-accessible parts of the great Archean Protaxis. The Grenville series is known to occupy a large part of its southern margin between the city of Quebec and the Georgian Bay, while the discovery of crystalline limestone in the gneiss elsewhere at several widely separated points, as for instance on the Hamilton River in Labrador, in the southern part of Baffin Land and on the Melville Peninsula, makes it probable that other considerable areas will, with the progress of geological exploration, be found in the far north. Over the greater part of the Protaxis, however, the more monotonous development of the Fundamental Gneiss seems to prevail.

The question of the origin and mutual relations of the Fundamental Gneiss and the Grenville series is one about which, though much has been written but little is known. Three views may be taken on the matter—

(1) The Fundamental Gneiss may be supposed to contain what remains of a primitive crust, penetrated by great masses of igneous rock erupted through it—the whole having been subjected to repeated dynamic action.[1] The Grenville Series may be an upward continuation or development of the Fundamental Gneiss under altered conditions, marking in the history of the world the transition from those conditions under which a primitive crust formed to those in which sedimentation under the present normal conditions took place. It would seem that if the earth originally had a crust on which the first sediments were deposited when the temperature became sufficiently low to permit water to condense, that the said water, at a very high temperature and under what are to us now inconceivable conditions but little removed from fusion, might give rise to sediments not altogether similar to those formed by the ordinary processes of erosion at the present time. Also that, under the unique conditions which must have prevailed at that early time, in the formation of a crust solidification, precipitation and sedimentation might go on to a certain extent concomitantly, and thus no well-defined break could be detected, or would in fact exist, between a primitive crust formed by solidification from a fused magma and the earliest aqueous sediments or deposits. The Fundamental Gneiss and the Grenville Series might thus, as Logan supposed, form one practically continuous series and represent parts of the original crust, with the first crystalline or clastic sediments deposited on it, the whole penetrated by eruptive rocks and folded up and altered by repeated dynamic action at subsequent periods.

The general petrographical similarity of the two series, taken in connection with the more varied nature of the Grenville Series,

[1] See also, The Geological History of the North Atlantic, by Sir William Dawson, Presidential Address, B. A. A. S., 1886.

its frequent stratified character, and the presence in it of limestones and graphite indicating an approach to modern conditions and the advent of life, together with the difficulty of clearly separating the two series from one another and defining their respective limits, lends support to this view.

(2) A second view is that the Grenville Series is distinct from the Fundamental Gneiss reposing on it unconformably and of much more recent age; that it consists of a highly altered series of clastic origin—the Fundamental Greiss having possibly some such origin as that mentioned under the last heading, or representing a much older series of still more highly altered sediments. This is supported by the fact that some observers have thought they could in places trace out a line of contact between the two. But in these cases it always becomes a matter of serious doubt whether what has been considered to represent the Fundamental Gneiss is not really a mass of intrusive rock, in which, by pressure or motion, a somewhat gneissic structure has been induced. If the Fundamental Gneiss, moreover, was ever an ordinary sediment, it must have undergone a metamorphosis so profound that no trace of clastic origin remains, unless the generally indistinct foliation or banding of some portions of it be considered as such. It must also be noted in this connection that, although the rocks of the Grenville series are more frequently possessed of a decided foliation and are often banded, bands of different composition alternating with one another as in ordinary sedimentary deposits, and although in this series crystalline limestones and quartzites occur, we have as yet no absolutely conclusive proof that even they are of sedimentary origin. The series is thoroughly crystalline, most of its members at least show the effect of great dynamic action, and so far as the present writer is aware, no undoubted conglomerate or finer grained rock showing distinct clastic structure has ever been found. In view of this fact,—although the series is, in all probability, made up in part at least and perhaps wholly of sedimentary material,—the proposal to separate it from the rest of the Laurentian and class it as Algonkian or Huronian seems at least premature.

(3) A third view which has been advanced is that the Fundamental Gneiss is nothing more than a great mass of eruptive granite or granitic rock which has eaten upward, and in places penetrated the Grenville series, or perhaps absorbed it, while the Grenville series itself represents a series of highly altered sediments of Laurentian, Huronian or subsequent age. The enormous extent and world-wide distribution of the Fundamental Gneiss forming as it does wherever the base of the geological column is exposed to view, the foundation or floor on which all subsequent rocks are seen to rest, is opposed to this view of its origin, as is also its persistent gneissic or banded character, although, as above mentioned, much eruptive material is undoubtedly to be found in it.

Which of these views is correct can be ascertained only as very careful and detailed mapping, accompanied by accurate petrographical study, is proceeded with. In the present state of our knowledge additional argument and discussion will not help us toward the goal, while hasty work and generalization serves but to retard the progress of our knowledge.

The Anorthosite Series.—Associated with both the series of rocks just described there are, as has been mentioned, great eruptive masses of granite, some of which have been folded in with the gneisses, while others evidently erupted at a much later date, show no trace of dynamic action.

In addition to these, basic eruptive rocks belonging to the gabbro family occur in certain districts, sometimes in the form of comparatively insignificant masses, but elsewhere underlying great tracts of country. One on the upper waters of the Saguenay has an area of no less than 5,800 square miles. These usually consist of a variety of gabbro in which the magnesia-iron constituents are present in very small amount, being in many cases entirely wanting, so that the rock consists practically of pure plagioclase feldspar. These rocks were called *anorthosites* by Hunt, in the early reports of the Canadian Geological Survey, on account of the great preponderance in them of "Anorthose,' a general name given many years ago by Delesse to the triclinic

feldspars, as distinguished from "Orthose," or orthoclase feldspar, and thus equivalent to the term plagioclase now in general use, but having no connection with anorthite, a variety of plagioclase which is seldom present. After a careful study of these rocks, both in the field and the laboratory, it is believed that this name should be retained for this well-marked member of the gabbro family, which, though not a common rock elsewhere, has an enormous distribution in the Laurentian of Canada.

If an olivine gabbro be regarded as the central member, so to speak, of the gabbro family, the replacement of the monoclinic by rhombic pyroxene will give rise to an olivine norite. A gradual diminution in the amount of plagioclase will give rise to a peridotite or gabbro pyroxenite, a diminution in the amount of pyroxene to a troktolite or plagioclase-olivine rock, while a diminution in the amount of olivine and pyroxene will give rise to an anorthosite, which variety forms the greater part of the intrusive masses in question. The gradual passage of one variety into another can be distinctly traced in many localities in the anorthosite masses. These anorthosites are in some places massive, but very frequently show a distinct foliation, often very perfect. In some places they occur interbanded with the gneiss and crystalline limestone, while elsewhere they cut directly across the strike of these rocks. The interbanded anorthosite, together with the gneiss and limestone associated with it, was supposed by Logan to form a distinct sedimentary series, to which the name "Upper Laurentian," or "Norian," was given, because the discovery that elsewhere the anorthosite runs across the strike of the gneiss was supposed to indicate that this series covered up and unconformably overlay the Grenville series, the igneous and intrusive character of the anorthosite not being recognized on account of its frequently foliated structure. It is now known that these anorthosites do not constitute an independent formation, but are igneous rocks which occur, cutting both the Grenville series and the Fundamental gneiss. They have, however, in many cases been intruded before the cessation of the great dynamic movements to which the Laurentian was

subjected in pre-Cambrian times, and thus frequently taking a line of least resistance and having been intruded between the bands or strata of the Grenville series, have had a foliation induced in them parallel to that of the gneiss, while in other cases where they are more or less massive, they cut across the the strike of the latter.

In many cases the anorthosites which exhibit a perfect foliation may be traced step by step into the massive variety, the gradual development of a foliated structure in the rock being accompanied by a progressive granulation of the constituents, most beautifully seen under the microscope. The change, however, differs from any hitherto described in that it is purely mechanical. There are no lines of shearing with accompanying chemical changes, but a breaking up of the constituents throughout the whole mass, though in some places this has progressed much further than in others, unaccompanied by any alteration of augite or hypersthene to hornblende, or of plagioclase to saussurite, these minerals, though prone to such alteration under pressure remaining quite unaltered, suffering merely a granulation with the arrangement of the granulated material in parallel strings. This process can be observed in all its stages, and there is reason to believe that it has been brought about by pressure acting on the rocks when they were deeply buried and very hot.[1] The anorthosite areas, of which there are about a dozen of great extent with many of smaller size, are distributed along the south and southeastern edge of the main Archean Protaxis from Labrador to Lake Champlain, occupying in this way a position similar to that of volcanoes along the edge of our present continents. Curiously enough precisely similar occurrences of this anorthosite have been found in connection with similar gneissic rocks, supposed to be of Archean age, in Russia, Norway and Egypt. These anorthosite rocks being intrusive, may be left out of consideration in endeavoring to work out the succession of the Archean in this great area.

[1] See FRANK D. ADAMS—"*Ueber das Norian oder Ober-Laurentian von Canada*," *Neues Jahrbuch für Mineralogie, etc., Beilageband VIII., 1893.*

The whole Laurentian system, including the anorthosites, is in many places cut by numerous dykes of large size, which can often be traced for great distances. These are of several kinds, the principal series consisting of a beautiful fresh diabase often holding quartz in considerable amount in micro-pegmatitic intergrowths with plagioclase. Other sets of dykes and eruptive masses consisting of augite and mica syenites, quartz-porphyries and other rocks are also known to occur but have not as yet been carefully studied.

The Hastings Series.—The stratigraphical relations of the Hastings series have not as yet been satisfactorily determined. The rocks constituting the series differ widely in petrographical character from those of the Fundamental Gneiss and the Grenville series, both of which are supposed to occur in its immediate neighborhood. The series consists largely of calc-schists, mica-schists, dolomites, slates and conglomerates, thus containing much material of undoubtedly clastic origin. It has moreover a very local development, being confined, so far as at present known, to one small corner of the area, as has been mentioned. It was by Logan supposed to come in above the Grenville series, while Vennor who subsequently examined the district, believed it to be equivalent to the lower part of this series. That we have in the Hastings series a comparatively unaltered part of the Grenville series, made up largely of rocks whose origin is easily recognized, would be a most important fact if established, and would, of course, afford a key to the whole question of the origin of the latter. This is a conclusion, however, which cannot be accepted until supported by very clear and decisive evidence, especially as the stratigraphy of the Hastings district is very complicated, the several series represented in it being much folded and penetrated by great masses of eruptive rocks. The whole district has also been subject to great dynamic action, some of the pebbles in the conglomerates of the Hastings series being distorted in a most remarkable manner. This series may prove to be merely an outlying area of Huronian rocks folded in with the Laurentian, and until the district has been studied in

detail its stratigraphical position must remain a matter of conjecture.

Leaving the Hastings series out of consideration therefore, we have in this Original and Typical Laurentian area two developments of the Laurentian, generally considered as constituting two series, namely the

Grenville or Upper series,
Fundamental, Ottawa, or Lower Gneiss.

The Evolution of the Area.—In endeavoring to outline the main events in the evolution of this area it will be necessary to extend the limits of our observation somewhat and seek for evidence bearing on the question in other parts of the Protaxis, where we meet with developments of Huronian and various earlier Paleozoic strata not found in the typical area itself.

From the highly contorted condition of the Laurentian rocks of this area as well as from the abundant evidences of dynamic action which they present both in the field and under the microscope, it is evident that they have been subjected to great orographic forces, which in very early times threw them up into mountain ranges, probably of great height. Some of the associated eruptive rocks were intruded before these movements began, or while they were in progress and have accordingly been influenced by them, while others, having been intruded later, have not been affected.

How high these mountains rose cannot of course be determined. Bell states that some of the mountains on the Labrador coast now rise to a height of from 5,000 to 6,000 feet, while Lieber has estimated that on the coast of Northern Labrador they rise to a height of from 6,000 to 10,000 feet. Along the southern part of the Protaxis, where the country is much lower, notwithstanding the enormous subaerial denudation and glaciation which the area has repeatedly undergone, there are many points still rising from 2,500 to 3,500 feet above sea level, while Logan estimated that the average elevation is from 1,500 to 1,600 feet. In the Adirondacks, which are but an outlying portion of this area, there are elevations of over 5,400 feet.

The high elevations attained by these rocks in portions of the Protaxis in the north may, of course, be due to differential elevation, but immediately along the southern edge of the area there can have been but little differential change of level as compared with the flat-lying Potsdam strata which border it and lie but little above the present sea level. Further evidence of the original height or continued uprising of the area is afforded by the fact that all the material of which the North American continent was built up (with the possible exception of some of the limestones) was derived originally from the Archean Protaxis of the continent, a considerable proportion of this at least coming from the main Protaxis of which this typical Laurentian area forms a part. We must conclude therefore that in early Cambrian or pre-Cambrian times, in portions of the Protaxis at least, the Laurentian mountains rose several hundred and possibly in places several thousand feet above the sea level.

The intrusion of the granites and anorthosites as well as the folding of the whole system of rocks took place before Upper Cambrian times. The whole series was moreover without doubt at that time in the "metamorphic" condition in which we now find it, for along the margin of the area the Potsdam sandstone rests in flat undisturbed beds on the deeply eroded remnants of these old mountains, its basal beds often consisting of a conglomerate with pebbles of the underlying gneissic rocks. These Cambrian strata cover up the gneisses, granites and anorthosites alike and are evidently of much more recent age, being separated from the Laurentian by the long interval occupied in the upheaval and erosion of the Laurentian area.

How long before Upper Cambrian times this folding and erosion took place cannot be determined from a study of this area, but further west along the edge of the Protaxis in the Lake Superior district we find that the Keweenawan, Nipigon and Animikie Series also repose in flat undisturbed beds on the eroded remnants of a series of crystalline rocks which have the petrographical character of the Fundamental Gneiss. This

makes it at least very probable that in this eastern area also the erosion took place in pre-Cambrian times.

It is a very remarkable fact that the roche moutonné character possessed by these eroded Laurentian rocks and which is usually attributed to the glaciation which they underwent in Pleistocene times, was really impressed upon them in the first instance in these pre-Cambrian times, for all along the edge of the nucleus from Lake Superior to the Saguenay, the Paleozoic strata, often in little patches, can be seen to overlie and cover up a mammillated and roche moutonné surface showing no traces of decay and similar to that exposed over the uncovered part of the area. The conclusion therefore seems inevitable that not only were these Laurentian rocks sharply folded and subjected to enormous erosion, but that they had given to them in pre-Cambrian times their peculiar hummocky contours so suggestive of ice action.[1] The pre-Paleozoic surface of the Fundamental Gneiss of Scotland, as Sir Archibald Geikie has shown, also presents the same hummocky character.[2] On this surface the Upper Huronian, Cambrian, and later Paleozoic rocks were deposited.

To what extent the seas of Cambrian, Silurian and Devonian times passed over this area cannot be determined with certainty. A great series of rocks referred to by Dr. G. M. Dawson as probably of Lower Cambrian age and analogous in character to the Keweenawan and Animikie series occur overlying the Laurentian in many parts of the Protaxis, not only along its margin, but as outliers at many places in the interior. It occurs extensively developed about the Arctic Ocean and about Hudson's Bay, and a large area of rocks referred to the same age also occur near the height of land about Lake Mistassini. "Throughout the whole of the vast northern part of the continent this characteristic Cambrian formation, composed largely of volcanic rocks, apparently occupies the same unconformable position with

[1] A. C. LAWSON.—"Notes on the Pre-Palaeozoic surface of the Archean Terranes of Canada." Bulletin of the Geological Society of America. Vol. 1, 1890.

[2] "A Fragment of Primeval Europe." Nature, August 26, 1888.

regard to the underlying Laurentian and Huronian systems. Its present remnants serve to indicate the position of some of the earliest geological basins, which from the attitude of the rocks appear to have undergone comparatively little disturbance. Its extent entitles it to be recognized as one of the most important geological features of North America."[1] It would, therefore, seem that in Cambrian times a not inconsiderable part of the Archean Nucleus was under water. Outliers of Cambro-Silurian age are also found at several points lying well within the margin of the Nucleus, as for instance in the Ottawa River about Pembroke at a distance of fifty miles, and at Lake St. John at the head of the Saguenay River at a distance of one hundred and thirty miles from its present limit. There is reason to believe that a similar outlier exists in the interior of the northern part of the Peninsula of Labrador, so that the Lower Paleozoic sea must also have covered considerable areas in the eastern half of the Protaxis, where now nothing but Laurentian is to be seen. In that portion of the Protaxis lying to the west of Hudson's Bay strata of Cambro-Silurian and Devonian age extend up from the basin of Hudson's Bay on the east and from the great plains on the west far over the Laurentian Plateau and probably, according to Dr. Dawson, originally inosculated. Strata of Upper Silurian and Devonian age are not known to exist in the eastern half of the Protaxis, of which the typical Laurentian area forms part, with the exception of a small outlier of Niagara age on Lake Temiscamangue at the head waters of the Ottawa—neither do any other deposits of later age occur with the exception of the Glacial Drift. What evidence there is, therefore, would rather indicate that the area, during late Paleozoic, Mesozoic and earlier Tertiary times, was out of water. If so, it must have undergone during this great lapse of ages a process of deep seated decay and denudation, culminating in the extensive glaciation to which it was subjected in Pleistocene times.

During this latter period the whole area was exposed to

[1] G. M. DAWSON.—"Notes to accompany a geological map of the northern portion of the Dominion of Canada." Report of the Geological Survey of Canada, 1886. p. 9, R.

ice action, with the exception of the highest part of the Nucleus —the mountains of the Labrador coast—which, except toward the base, are still "softened, eroded and deeply decayed."[1] This extensive denudation served to remove all but mere remnants of any Paleozoic strata originally deposited on the Archean of this area, while the deep decay of the Archean rocks themselves would account for the immense numbers of gneiss bowlders in the drift, which in all probability are but smoothed cores of "bowlders of decomposition." That an immense amount of material was removed from the surface of the area during the glacial age is shown by the immense quantities of Archean material which occurs scattered over the surface of the Nucleus itself, as well as in the drift to the south. The glaciation, with the depression and uplift which succeeded it, was the last episode in the evolution of this "original" Laurentian area and one which impressed upon it its present surface characters and type of landscape.

It is now an immense uneven plateau, comparatively slightly accentuated except along the Labrador coast. The surface is covered with glaciated hills and bosses of rock with rounded, mammilated, flowing contours interspersed with drift covered flats and studded with thousands upon thousands of lakes great and small. A country which in the far north is often bleak and desolate, but to the south, where it is covered with luxuriant forest, is often of great beauty, especially when clothed with the brilliant foliage of autnmn. Even now, however, it is passing into a further stage of its history, the smooth or polished glaciated surfaces are becoming roughened by decay, the softer gneissic and limestone strata are again commencing to crumble into soil, and a new epoch has been inaugurated in which the marks of the ice age are being gradually effaced.

FRANK D. ADAMS.

McGILL UNIVERSITY.

[1] ROBERT BELL.—"Observations on the Geology etc., of the Labador Coast, Hudson's Strait and Bay." Report of the Geological Survey of Canada. 1882–3–4, p. 14, DD.